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Maryland Agriculture and Your Watershed

MARYLAND DEPARTMENT OF AGRICULTURE

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Abstract

Using primarily 1995 State of Maryland agricultural statistics data, a new methodology was demonstrated with which State natural resource managers can analyze the areal extent of agricultural lands and production data on a watershed basis. The report organized major crop and livestock data onto the 19 United States Geological Survey hydrologic unit code 8-digit watersheds in Maryland. Organizing the data according to watersheds provides a different perspective on agricultural production, because it helps to understand the potential impacts within each Maryland watershed and potentially on a regional basis when watershed boundaries overlap state lines. Data on the overall extent of crop and livestock activity within each watershed are presented in order to provide a clearer understanding of each watershed's agricultural intensity. Also information on fertilizer and pesticide use is provided to illustrate the context of issues surrounding environmental concerns and water quality. In addition, a discussion is presented on the programs and management practices being implemented in Maryland to reduce the impacts of agricultural production on the environment.

Keywords: Agriculture, Watershed, Maryland Agriculture, Agricultural Production, Agricultural Intensity, Maryland, Statistics, Methodology, Crops, Livestock.

Notice

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General information on the Mid-Atlantic Integrated Assessment can be found through the World Wide Web at http://www.epa.gov/maia

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Acknowledgments

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The preparation of a primer such as this would be impossible without the devoted assistance of numerous people. Space permits only a few to be mentioned here. The authors gratefully acknowledge the following people. Mrs. M. Patricia Bradley of the MAIA Team, U.S. EPA, prepared the extramural vehicles which funded this work. Mr. Bruce West, Mr. Harry DeLong, and Mr. Charles Less of the Maryland Agricultural Statistics Service assisted with the initial planning of the project. Mr. Roland Agbede of the Maryland Department of Agriculture assisted with the preparation of some of the geographic information system portrayals used in this report. Mr. Fred Schenerman of the Maryland Department of Business and Economics and Mr. James Ahl of the Maryland Department of Natural Resources assisted with analysis of the livestock data. We would also like to thank Jennifer Baker, Sandy Paul, and Eric Grape of Versar, for their assistance in the editorial review, design and layout of this publication. Finally we would like to recognize the efforts and guidance of this report's four peer reviewers: Mrs. Laurie Adelhardt, Owl Creek Consulting; Ms. Christine Conn and Mr. John Wolf, Maryland Department of Natural Resources; and Mrs. Ann Pitchford, U.S. EPA.

Special thanks are given to Mr. Thomas B. DeMoss of the MAIA Team (EPA Region 3) for his advice and guidance throughout this effort. It is with regret that the authors report the untimely death of Mr. Bruce West in June 1999.

INTRODUCTION

This report presents statistical data representing environmentally relevant attributes of the Maryland agriculture production system. This report will give readers a better understanding of the agricultural production system within Maryland's watersheds and its possible environmental impacts. Using primarily 1995 data from the Maryland Department of Agriculture, it discusses the extent of crops and their environmentally relevant attributes by watershed. Organizing the data according to the 19 watersheds in the state provides a different perspective on agricultural production, because it helps to understand the potential impacts within each Maryland watershed. While this report does not associate agricultural protection with environmental condition, summary data are provided on the application of agricultural chemicals (fertilizers, pesticides, etc.) and related environmental indicators.

The purpose of this document is to transfer information on a demonstrated methodology for estimating the areal extent of agricultural production on a watershed basis. It is hoped that other states will utilize this methodology which takes agricultural statistics and re-projects them on a watershed basis to estimate the extent of agricultural lands and production. Watersheds often cross the boundaries of two or more states, therefore having agricultural data on a watershed basis from each state will allow resource managers to compare agricultural data across state lines and gain a regional perspective. It is important to reiterate that this report is intended to demonstrate a methodology, not to be a comprehensive study of all agricultural activities of environmental concern in Maryland. It is hoped that this methodology demonstration will spur future interest in conducting more comprehensive analyses of the relationships between agricultural production and the environment on a watershed basis.

This report consists of the following five major sections and appendix:

Introduction - The introduction section presents an overview of agriculture in Maryland and briefly describes the major sections of this report.

Crops - This is the major section of the document, reporting on the areal extent (acres) of several types of crops produced within Maryland. Information is presented on soybeans, corn, wheat, hay, barley, tobacco, and oats production, according to the 19 U.S. Geological Survey (USGS) eight-digit watersheds in Maryland.

Many crops produced in Maryland were not included in this study, such as rye, potatoes, apples, peaches, mushrooms, and forest products, so it is not a comprehensive study We chose for this analysis some of Maryland's largest individual crops in terms of acres harvested, production, and/or cash receipts. We felt that for the purposes of this study, these seven crops provided an adequate representation of the application of this methodology to Maryland's agricultural production system.

Livestock - This section provides data on the extent of livestock operations in Maryland, including cattle, calves, and milk cows. These data are summarized on Maryland's smaller watersheds (the Maryland eight-digit watersheds).

What Is a Watershed?

It's the area of land that catches rain and snow that drains or seeps into a marsh, stream, river, lake, or groundwater (U.S. EPA, 1999a).

How are Watersheds Defined and Organized?

Watersheds are delineated by the U.S. Geological Survey (USGS) based on surface hydrologic features. Watersheds can be defined on very large scales (such as the Chesapeake Bay watershed, which covers five states) or on smaller scales. Watersheds delineated by the USGS are given both names and hydrologic unit codes (HUCs) in order to organize and identify the watersheds. For the names and HUCs of the 19 USGS eight-digit watersheds within Maryland, see Figure 1. In this report, crop acreage data are presented for the 19 eight-digit watersheds in the state of Maryland. Smaller Maryland eight-digit watersheds, of which there are 138, are used to present the livestock data. The term "watershed" will be used interchangeably, but we will clearly state when we are referring to the larger USGS eight-digit watersheds and when we are referring to the smaller Maryland eight-digit watersheds.

Although broilers (chickens) are one of Maryland's largest livestock commodities, they were not included for analysis in this study due to the challenges involved in estimating their numbers on a watershed basis (See Appendix for further explanation).

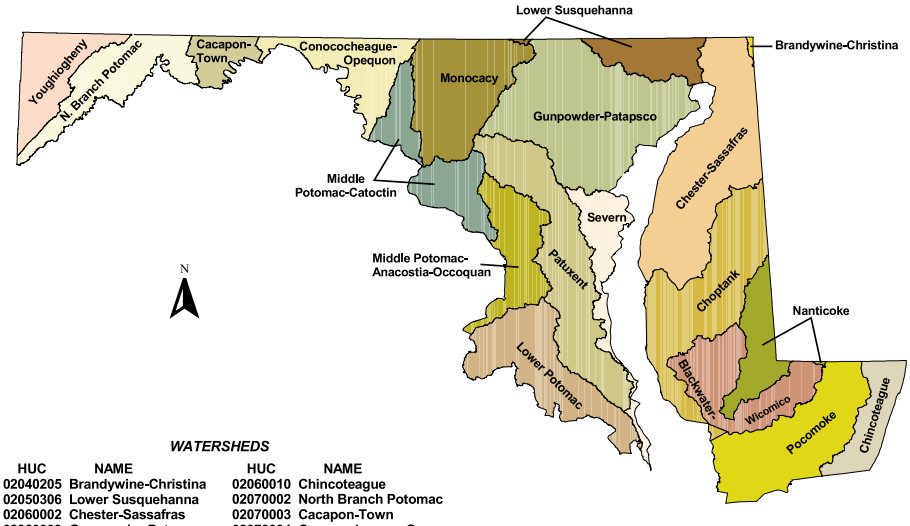
Agricultural Intensity by Watershed - This section presents an integrated watershed assessment, including a summation of the extent of agricultural production within each watershed.

Environmental Concerns - This section describes concerns about water quality impacts that may result from agriculture. Furthermore, this section presents summary data on the application of agricultural chemicals (fertilizers, pesticides, etc.) and provides examples of environmental programs and management practices already in place to reduce agricultural impacts on water quality.

Appendix: Methodology - The sources and methodologies used to organize and analyze the data are described in this appendix. Agricultural data collected by the Maryland Agricultural Statistics Service are the result of intensive surveys; they provide estimates of the areal extent of various crop types, with known levels of statistical confidence. Also included in this appendix are the procedures used to apportion the agricultural extent data to watersheds in Maryland.

Overall, this document presents data about agricultural land use and production in the state of Maryland, primarily based on 1995 data. Such information is useful to many people who are working to improve agricultural practices and reduce water quality impacts. In addition, the land cover and crop type data for each watershed can be used to estimate nonpoint source loadings to waterbodies, such as the type needed by Total Maximum Daily Load (TMDL) programs. This information is critical for characterizing current loadings and measuring the efficacy of control efforts.

Figure 1. USGS 8-Digit HUCs in Maryland



WATERSHEDS

HUC	NAME	HUC	NAME
02040205	Brandywine-Christina	02060010	Chincoteague
02050306	Lower Susquehanna	02070002	North Branch Potomac
02060002	Chester-Sassafras	02070003	Cacapon-Town
02060003	Gunpowder-Patapsco	02070004	Conococheague-Opequon
02060004	Severn (W)	02070008	Middle Potomac-Catoctin
02060005	Choptank	02070009	Monocacy
02060006	Patuxent (W)	02070010	Middle Potomac-Anacostia-Occoquan
02060007	Blackwater-Wicomico	02070011	Lower Potomac
02060008	Nanticoke	05020006	Youghiogheny
02060009	Pocomoke	(W) Watershed wholly within Maryland	

Overview of Maryland Agriculture

Agriculture is a significant sector of the Maryland economy. As the state's largest commercial industry, agriculture contributes more than $17 billion in revenue annually (MDA, 1998a). Today, 14 percent of the state's workforce, 400,000 individuals, are somehow involved in Maryland's food and fiber sector (MDA, 1998a). The agricultural production system in Maryland is diverse, as many different types of crops are produced. The major crops in Maryland include corn, soybeans, tobacco, small grains, vegetables, nursery products, and fruit. In 1997, the value of Maryland crops sold totaled approximately $458 million (MDA, 1999). Some of the major crops discussed in this report (e.g., corn, soybeans), had a total value in 1997 of approximately $278 million (Figure 2). In addition, Maryland produces poultry, dairy products, and livestock, with values totaling more than $850 million in 1997 (MDA, 1999).

In 1997, 12,990 farms in Maryland accounted for approximately 2,175,004 acres (USDA, 1999b). Approximately 40 percent of Maryland's land is in agriculture (MDA, 1998a). From 31-50% of the land in the watersheds bordering the eastern and northern banks of the Chesapeake Bay are farmland, based on the 1995 data (Figure 3). Watersheds surrounding the Chesapeake Bay and in central Maryland have the largest areas of farmland (Figure 4). Each of these watersheds contained from 52,000 to 359,000 acres of farmland. The Chester-Sassafras Watershed (02060002), bordering the northeastern bank of the Chesapeake, contained the largest amount of farmland at 359,069 acres. The smallest amount of farmland was located in western Maryland, where three watersheds each contained 7,000 to 52,000 acres.

USGS 8-digit Watersheds in MD

Blackwater-Wicomico
Brandywine-Christina
Cacapon-Town
Chester-Sassafras
Chincoteague
Choptank
Conococheague-Opequon
Gunpowder-Patapsco
Lower Potomac
Lower Susquehanna
Middle Potomac-Anacostia-Occoquan
Middle Potomac-Catoctin
Monocacy
Nanticoke
North Branch Potomac
Patuxent
Pocomoke
Severn
Youghiogheny

Figure 2. Values of Select Maryland Crops Sold in 1997

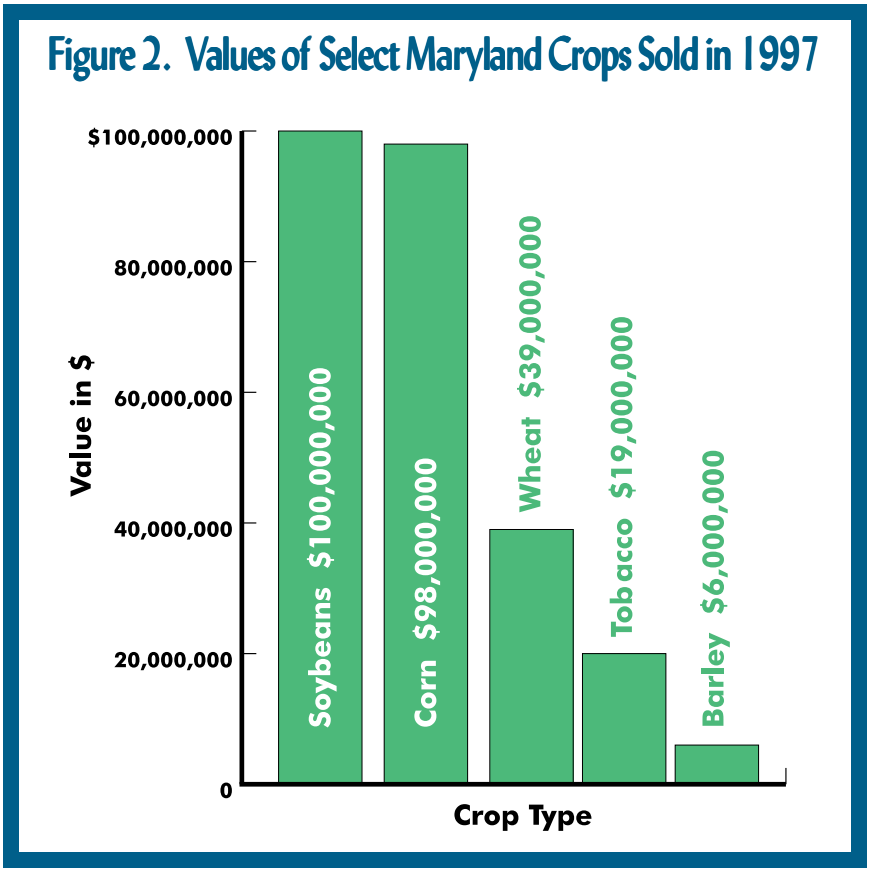
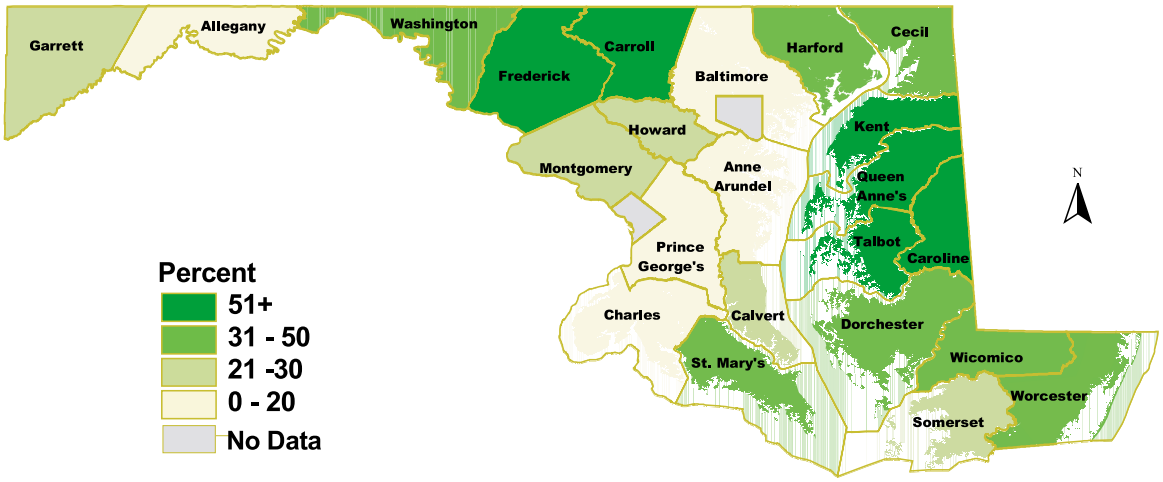
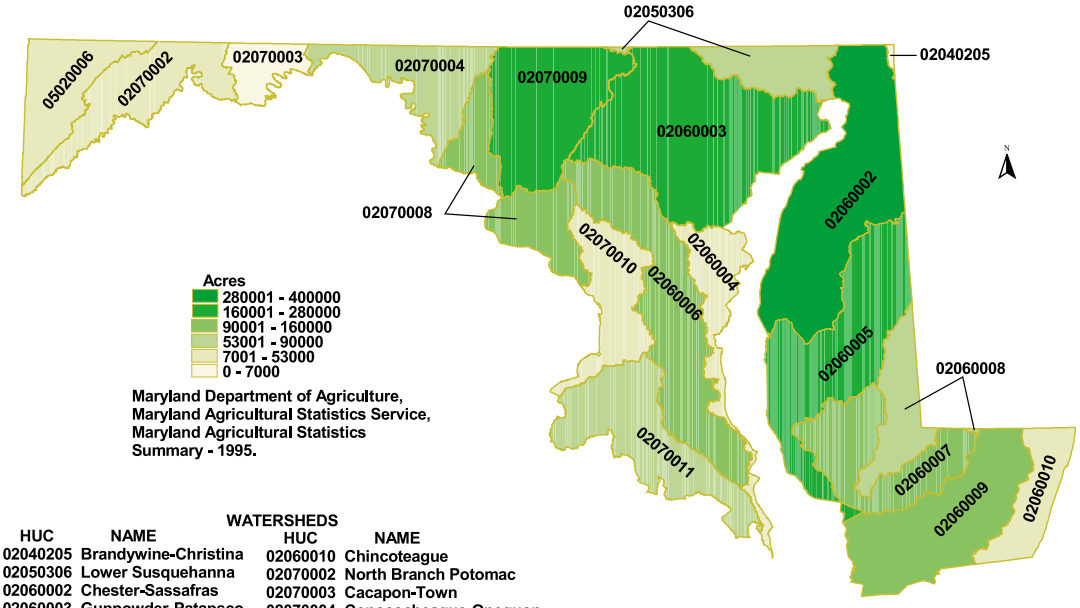


Figure 3. Maryland Percent Farmland by County



Maryland Department of Agriculture,
Maryland Agricultural Statistics Service,
Maryland Agricultural Statistics
Summary - 1995.

Figure 4. Farmland in Acres by Watershed - 1995



Maryland Department of Agriculture,
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Maryland Agricultural Statistics
Summary - 1995.

WATERSHEDS

HUC	NAME	HUC	NAME
02040205	Brandywine-Christina	02060010	Chincoteague
02050306	Lower Susquehanna	02070002	North Branch Potomac
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02060003	Gunpowder-Patapsco	02070004	Conococheague-Opequon
02060004	Severn	02070008	Middle Potomac-Catoctin
02060005	Choptank	02070009	Monocacy
02060006	Patuxent	02070010	Middle Potomac-Anacostia-Occoquan
02060007	Blackwater-Wicomico	02070011	Lower Potomac
02060008	Nanticoke	05020006	Youghiogheny
02060009	Pocomoke		

CROPS

This section presents information on the extent of several of Maryland's crops by watershed. The crops presented in this document are:

- Soybeans,
- Corn,
- Wheat,
- Hay,
- Barley,
- Tobacco, and
- Oats.

These crops were selected for analysis because they are some of Maryland's largest individual crops (Table 1). In 1995, these crops were in the top nine in terms of acres harvested, production, and cash receipts. Collectively, these seven crops acounted for approximately $233,508,000 in cash receipts in 1995 (MDA, 1995). In each crop analysis section, this report discusses the extent of the crop statewide, and the USGS 8-digit watersheds that contain the largest and smallest numbers of acres harvested or planted. Information in the Appendix describes the procedures used to create these crop estimates.

Table 1. Overview of Major Crops in Maryland (1995)

Crop	Acreage	Value	Trends (Acres Harvested)
Soybeans	550,000	$75 million	↑
Corn	440,000	$60 million	↓
Wheat	225,000	$56 million	↑
Hay	205,000	$14 million	↔
Barley	65,000	$6 million	↓
Tobacco	8,500	$21 million	↓
Oats	8,000	<$1 million	↓

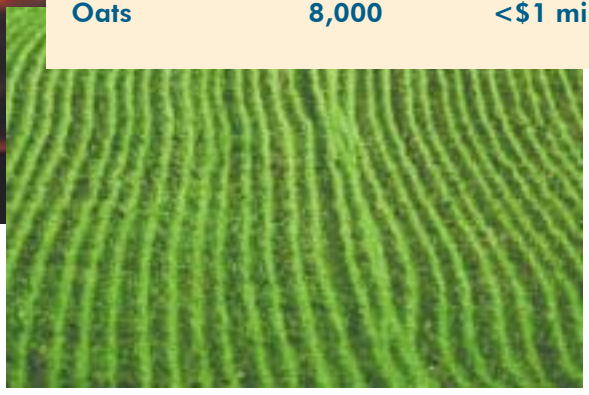
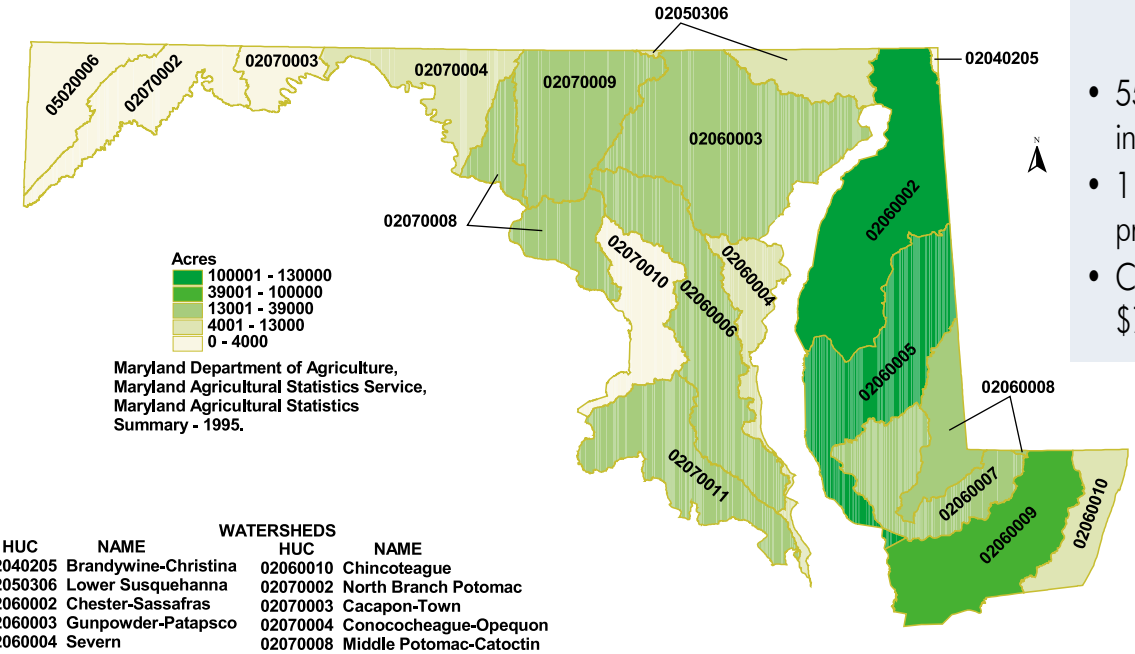


Figure 5. Soybean Acreage by Watershed - 1995



WATERSHEDS

HUC	NAME	HUC	NAME
02040205	Brandywine-Christina	02060010	Chincoteague
02050306	Lower Susquehanna	02070002	North Branch Potomac
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02060005	Choptank	02070009	Monocacy
02060006	Patuxent	02070010	Middle Potomac-Anacostia-Occoquan
02060007	Blackwater-Wicomico	02070011	Lower Potomac
02060008	Nanticoke	05020006	Youghiogheny
02060009	Pocomoke		

Soybeans

- 550,000 acres planted in 1995
- 11,730,000 bushels produced
- Cash receipts totaled $75,442,000

Soybeans

Between 1980 and 1995, harvested acres for soybeans in Maryland increased by 120,000 acres. By 1995, soybeans ranked third after corn and wheat in terms of bushels produced and was the largest crop in terms of acres harvested and cash receipts.

In 1995, approximately 550,000 acres of soybeans were planted in Maryland. The map in Figure 5 represents the number of acres planted by watershed. Several watersheds bordering the eastern, northern, and western banks of the Chesapeake Bay contained a large amount of land used for planting soybeans, ranging from 13,001-120,727 acres. In addition, several watersheds in central Maryland contained a large amount of land used for planting soybeans, ranging from 13,001-39,000 acres. However, the Chester-Sassafras (02060002) and Choptank (02060005) watersheds, bordering the eastern and northeastern banks of the Chesapeake, and the Pocomoke (02060009) and Nanticoke (02060008) watersheds, on the eastern shore of Maryland, contained the most amount of land used for planting soybeans, containing 120,727 acres, 112,912 acres, 64,292 acres, and 38,074 acres, respectively. These four watersheds alone contained approximately 60 percent of the entire land area planted for soybeans in Maryland. The far western area of the state contained the smallest amount of land used for planting soybeans in 1995; the three watersheds in that area contained less than 4,000 acres. The Youghiogheny (05020006) watershed contained the smallest amount of land used for planting soybeans at 40 acres.

Corn

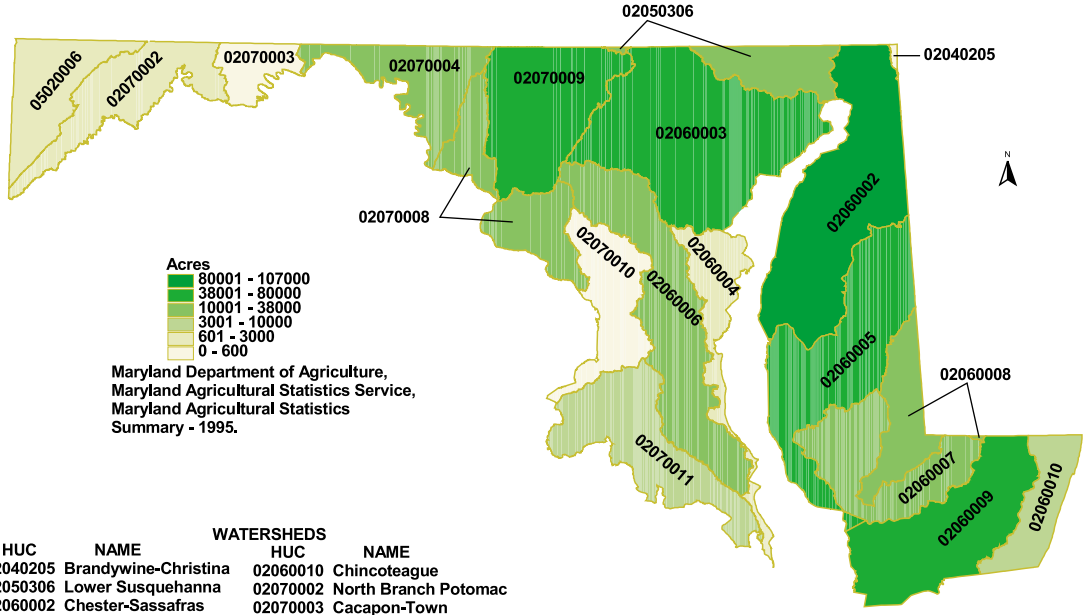
Corn is traditionally one of Maryland's largest crops in terms of acres harvested, production, and cash receipts. In 1995, corn ranked second in acres harvested, first in bushels produced, and second in cash receipts.

In 1995, approximately 450,000 acres in Maryland were harvested for corn. The map in Figure 6 represents the number of acres harvested by watershed. Several watersheds bordering the eastern and northern banks of the Chesapeake Bay contained a large amount of land used for harvesting corn, ranging from 38,001 to more than 106,000 acres. In addition, several central Maryland watersheds contained large amounts of land used for harvesting corn, ranging from 10,001 to 80,000 acres. However, the Chester-Sassafras (02060002), and Choptank (02060005) watersheds, bordering the eastern and northeastern banks of the Chesapeake, and the Gunpowder-Patapsco (02060003) watershed, bordering the northwestern corner of the Chesapeake, contained the largest amount of land used for harvesting corn at 106,622 acres, 61,641 acres, and 51,519 acres, respectively. These three watersheds collectively contained almost 50 percent of the total harvested acreage of corn in the state. The far western area of the state contained the smallest amount of land used for harvesting corn in 1995; the three watersheds in that area each contained less than 3,000 acres.

Corn

- 450,000 acres harvested in 1995
- 42 million bushels produced
- Cash receipts totaled $59,903,000

Figure 6. Corn Acreage by Watershed - 1995



WATERSHEDS

HUC	NAME	HUC	NAME
02040205	Brandywine-Christina	02060010	Chincoteague
02050306	Lower Susquehanna	02070002	North Branch Potomac
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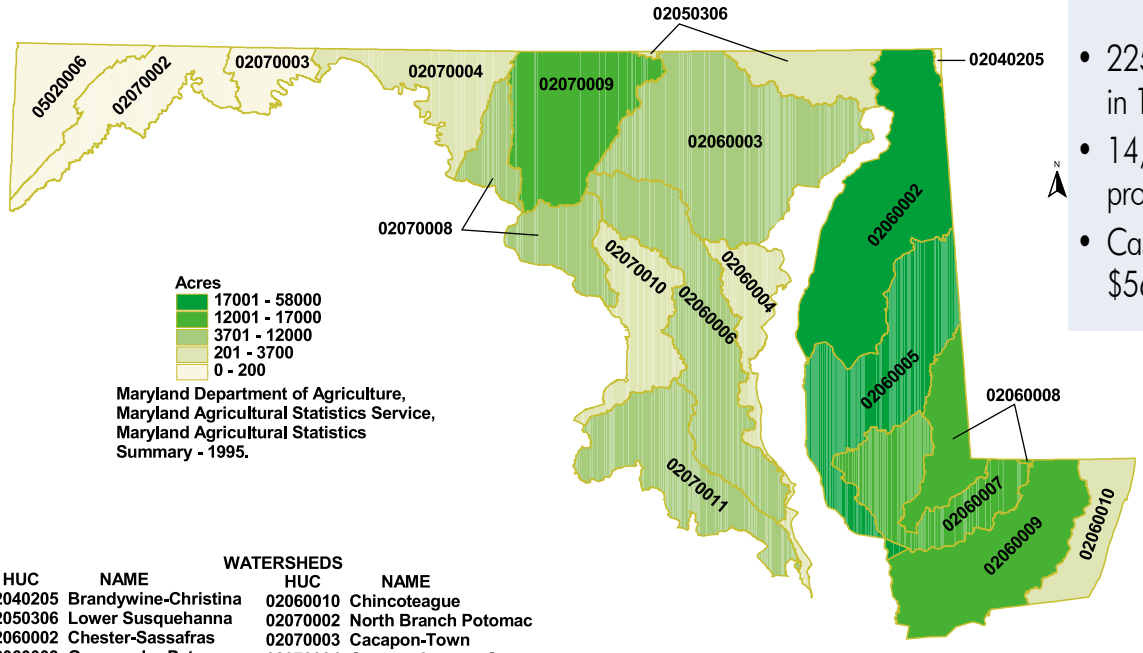
02060003	Gunpowder-Patapsco	02070004	Conococheague-Opequon
02060004	Severn	02070008	Middle Potomac-Catoctin
02060005	Choptank	02070009	Monocacy
02060006	Patuxent	02070010	Middle Potomac-Anacostia-Occoquan
02060007	Blackwater-Wicomico	02070011	Lower Potomac
02060008	Nanticoke	05020006	Youghiogheny
02060009	Pocomoke		

Figure 7. Wheat Acreage by Watershed - 1995



WATERSHEDS

HUC	NAME	HUC	NAME
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02050306	Lower Susquehanna	02070002	North Branch Potomac
02060002	Chester-Sassafras	02070003	Cacapon-Town
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02060005	Choptank	02070009	Monocacy
02060006	Patuxent	02070010	Middle Potomac-Anacostia-Occoquan
02060007	Blackwater-Wicomico	02070011	Lower Potomac
02060008	Nanticoke	05020006	Youghiogheny
02060009	Pocomoke		

Wheat

- 225,000 acres in 1995
- 14,400,000 bushels produced
- Cash receipts totaled $56,447,000

Wheat

Although not as large a crop as corn or soybeans, in terms of acres harvested or cash receipts, wheat is one of Maryland's largest and most important commodities. Between 1980 and 1995, harvested acreage for wheat in Maryland increased by 128,000 acres. By 1995, wheat ranked third in Maryland after corn and soybeans in terms of acres harvested and cash receipts. In addition, wheat ranked second after corn in terms of bushels produced. Approximately 225,000 acres of wheat were harvested in Maryland in 1995.

The map in Figure 7 represents the number of acres planted for wheat by watershed. Several watersheds bordering the eastern, western, and northern banks of the Chesapeake Bay contained a large amount of land used for planting wheat, ranging from 3,701 to 58,000 acres. The Chester-Sassafras (02060002), Choptank (02060005), Blackwater-Wicomico (02060007), and Pocomoke (02060009) watersheds, in eastern and southeastern Maryland, contained the most land used for planting wheat at 57,962 acres, 51,974 acres, 16,636 acres, and 16,068 acres, respectively. These four watersheds alone contained approximately 63 percent of the total number of acres planted for wheat in Maryland. The far western area of the state contained the smallest amount of land used for planting wheat in 1995; the three watersheds in that area each contained less than 200 acres. The North Branch Potomac (02070002) watershed contained the smallest amount of land used for planting wheat at 20 acres.

Hay

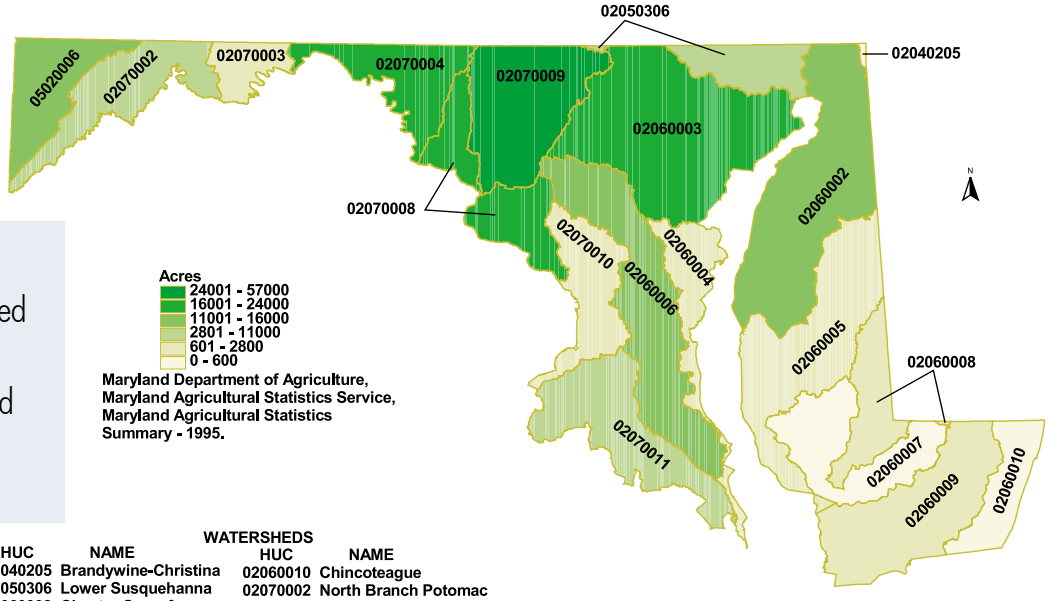
In 1995, hay was the fourth largest crop in Maryland in terms of acres harvested and fifth in terms of cash receipts.

In 1995, approximately 205,000 acres in Maryland were harvested for hay, and approximately 552,000 tons were produced. The map in Figure 8 represents the amount of land used for harvesting hay by watershed. Harvested acreage of hay in Maryland for 1995 was largest in the central and western Maryland watersheds, as well as those surrounding the northern and western banks of the Chesapeake Bay. The Monocacy (02070009), Middle Potomac-Catoctin (02070008), Conococheague-Opequon (02070004) and Gunpowder-Patapsco (02060003) watersheds, in central Maryland, contained the largest amount of land used for harvesting hay at 56,218 acres, 23,440 acres, 23,098 acres, and 19,008 acres, respectively. These four watersheds alone contained almost 50 percent of the total number of acres harvested for hay in Maryland. Southeastern Maryland contained the least amount of land used for harvesting hay; watersheds in that area each contained less than 2,800 acres in 1995. The Brandywine-Christina (02040205) watershed, in northeastern Maryland, and the Chincoteague (02060010) watershed, on the eastern shore, contained the smallest amount of land used for harvesting hay at 54 acres and 413 acres, respectively.

Hay

- 205,000 acres harvested in 1995
- 552,000 tons produced
- Cash receipts totaled $14,333,000

Figure 8. Hay Acreage by Watershed - 1995



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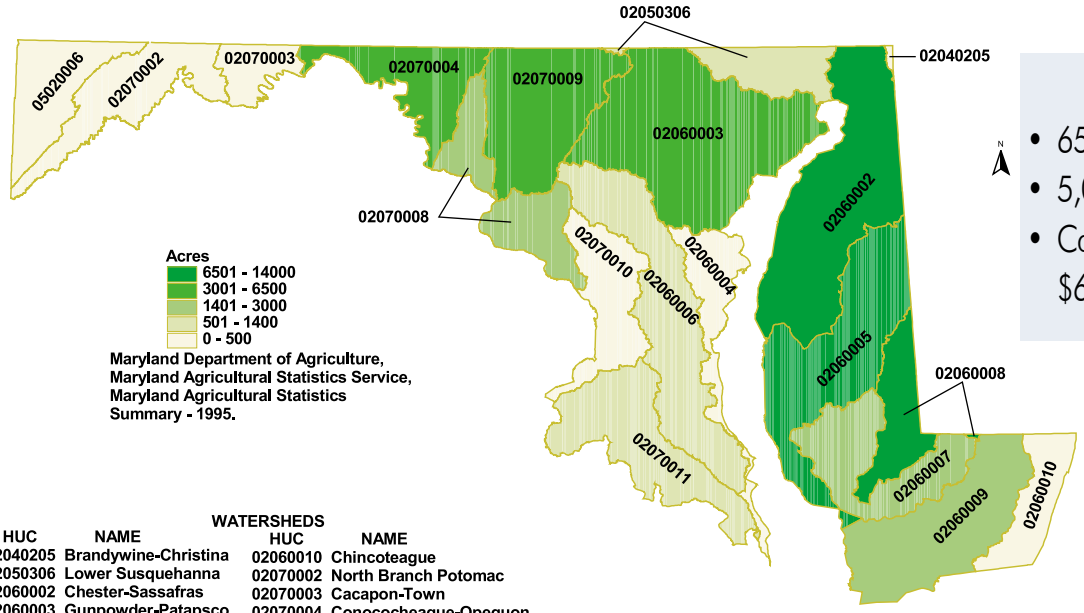
02060007	Blackwater-Wicomico	02070011	Lower Potomac
02060008	Nanticoke	05020006	Youghiogheny
02060009	Pocomoke		

Figure 9. Barley Acreage by Watershed - 1995



WATERSHEDS

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02060006	Patuxent	02070010	Middle Potomac-Anacostia-Occoquan
02060007	Blackwater-Wicomico	02070011	Lower Potomac
02060008	Nanticoke	05020006	Youghiogheny
02060009	Pocomoke		

Barley

- 65,000 acres planted in 1995
- 5,022,000 bushels produced
- Cash receipts totaled $6,374,000

Barley

Between 1985 and 1995, total harvested acreage for barley in Maryland decreased by 34,000 acres. However, in 1995, barley was still the fifth largest crop in Maryland in terms of acres harvested, fourth in terms of bushels produced, and sixth in terms of cash receipts.

In 1995, approximately 65,000 acres in Maryland were planted for barley and 5,022,000 bushels were produced. The map in Figure 9 represents the number of acres harvested for barley by watershed. Watersheds surrounding the eastern and northern banks of the Chesapeake Bay, as well as those in central Maryland, each contained the largest amount of land used for planting barley, ranging from 3,001-14,000 acres.

The Chester-Sassafras (02060002), Choptank (02060005), Nanticoke (02060008), and Gunpowder-Patapsco (02060003) watersheds, in northern and eastern Maryland, contained the largest amount of land used for planting barley at 13,564 acres, 12,292 acres, 10,926 acres, and 6,116 acres, respectively. These four watersheds alone contained more than 65 percent of the total number of acres in Maryland harvested for barley. In general, the watersheds bordering the western shore of the Chesapeake Bay and the watersheds in western Maryland each contained the smallest amount of land used for planting barley as they each contained less than 1,400 acres.

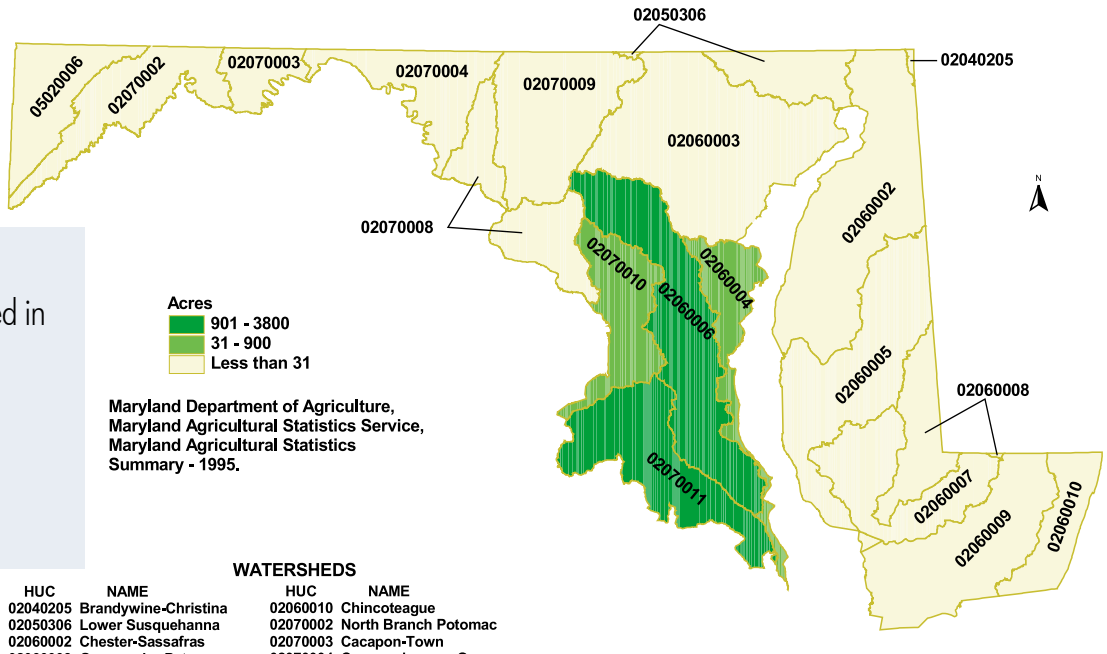
Tobacco

Although the total amount of land harvested for tobacco in Maryland declined by approximately 18,500 acres, or almost 69 percent, between 1982 and 1995, tobacco was still Maryland's fourth largest crop in terms of cash receipts in 1995, accounting for more than $20 million.

In 1995, approximately 8,500 acres in Maryland were harvested for tobacco and approximately 11,475,000 pounds were produced. The map in Figure 10 represents the amount of land used for harvesting tobacco by watershed in 1995. Harvested acreage of tobacco was largest in the four southern Maryland watersheds.

In 1995, the Patuxent (02060006), Lower Potomac (02070011), Middle Potomac-Anacostia-Occoquan (02070010), and Severn (02060004) watersheds contained approximately 8,468 of the total 8,500 acres of land used for harvesting tobacco in Maryland. The Lower Potomac (02070011) and Patuxent (02060006) watersheds contained the largest amount of land used for harvesting tobacco at 3,777 acres, and 3,233 acres, respectively. Each remaining watershed in Maryland contained less than 30 acres of land used for harvesting tobacco in 1995.

Figure 10. Tobacco Acreage by Watershed - 1995



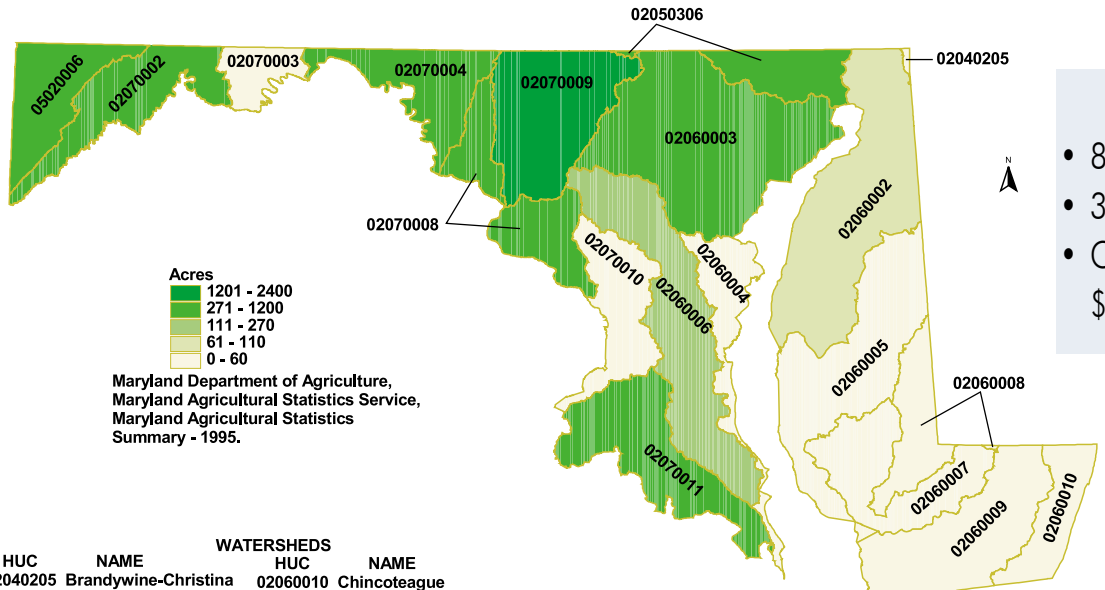
WATERSHEDS

HUC	NAME	HUC	NAME
02040205	Brandywine-Christina	02060010	Chincoteague
02050306	Lower Susquehanna	02070002	North Branch Potomac
02060002	Chester-Sassafras	02070003	Cacapon-Town
02060003	Gunpowder-Patapsco	02070004	Conococheague-Opequon
02060004	Severn	02070008	Middle Potomac-Catoctin
02060005	Choptank	02070009	Monocacy
02060006	Patuxent	02070010	Middle Potomac-Anacostia-Occoquan
02060007	Blackwater-Wicomico	02070011	Lower Potomac
02060008	Nanticoke	05020006	Youghiogheny
02060009	Pocomoke		

Tobacco

- 8,500 acres harvested in 1995
- 11,475,000 pounds produced
- Cash receipts totaled $20,869,000

Figure 11. Oats Acreage by Watershed - 1995



WATERSHEDS

HUC	NAME	HUC	NAME
02040205	Brandywine-Christina	02060010	Chincoteague
02050306	Lower Susquehanna	02070002	North Branch Potomac
02060002	Chester-Sassafras	02070003	Cacapon-Town
02060003	Gunpowder-Patapsco	02070004	Conococheague-Opequon
02060004	Severn	02070008	Middle Potomac-Catoctin
02060005	Choptank	02070009	Monocacy
02060006	Patuxent	02070010	Middle Potomac-Anacostia-Occoquan
02060007	Blackwater-Wicomico	02070011	Lower Potomac
02060008	Nanticoke	05020006	Youghiogheny
02060009	Pocomoke		

Oats

- 8,000 acres planted in 1995
- 366,000 bushels produced
- Cash receipts totaled $140,000

Oats

Another important crop within Maryland's agricultural production system is oats. Although the total number of acres harvested for oats in Maryland decreased by 13,000 acres between 1980 and 1995, oats was still the eighth largest crop in terms of acres harvested and fifth largest crop in terms of bushels produced in 1995.

In 1995, approximately 8,000 acres in Maryland were planted for oats, and approximately 366,000 bushels were produced. The map in Figure 11 represents the amount of land planted for oats by watershed. In 1995, harvested acreage for oats in Maryland was largest in the central and western Maryland watersheds, as well as those surrounding the northern and western banks of the Chesapeake Bay. The Monocacy (02070009), Lower Susquehanna (02050306), and Conococheague-Opequon (02070004) watersheds in central Maryland, and the Youghiogheny (05020006) watershed, in western Maryland, contained the largest amount of land used for planting oats at 2,348 acres, 881 acres, 786 acres, and 1,141 acres, respectively. These four watersheds alone contained approximately 85 percent of the total amount of land used for planting oats in Maryland. Southeastern Maryland contained the smallest amount of land used for planting oats; watersheds in that area contained 0-60 acres each in 1995. No land was used for planting oats in the Nanticoke (02060008), Chincoteague (02060010), Middle Potomac-Anacostia-Occoquan (02070010), and Brandywine- Christina (02040205) watersheds.

LIVESTOCK

Another significant part of the agricultural production system in Maryland is livestock. In 1995, livestock and its products accounted for $830,526,000 in cash receipts (MDA,1995). As significant as the livestock industry is to Maryland's agricultural production system, it is also important to understand the impacts livestock can have on the surrounding environment. The increasingly concentrated and confined nature of livestock farm operations has raised many concerns relating to environmental impacts. For instance, livestock can trample riverbanks, destroy vegetation, and stir up sediments in streambeds, which can lead to soil erosion and nutrient pollution. In addition, if not managed efficiently, animal waste runoff, which contains high concentrations of nutrients, can have adverse effects on nearby rivers and streams.

The data presented for livestock include the numbers of cattle and calves, milk cows, and pasture acres. There are many other livestock commodities in Maryland in addition to the ones chosen for analysis in this report, such as broilers, hogs, eggs, turkeys, sheep, horses, wool, and honey. However, because this report is not a comprehensive study, only cattle and calves, milk cows, and pasture acres were chosen for analysis. Cattle and calves and milk cows represent two of the three largest livestock commodities in Maryland in terms of cash receipts. The largest livestock commodity in Maryland in terms of cash receipts is broilers, which accounted for over $500,000,000 in 1997. The reason that broilers were not included in this analysis is because of the many challenges involved in estimating their numbers on a watershed basis (see Appendix for further explanation).

The Maryland livestock data were taken primarily from the 1992 Census of Agriculture (USDOC, 1994) and are presented by the smaller Maryland eight-digit watersheds. Maryland has 138 of these smaller watersheds, and their sizes vary widely. The largest of these watersheds is 297,604 acres (about 465 square miles), while the smallest is 4,488 acres (about 17 square miles). Interestingly, both of these watersheds are located in the mid-Atlantic coastal plain. Use of the smaller watersheds illustrates another approach to analysis and display of these data. It should be noted that certain data elements could not be displayed on these small-scale maps because it could compromise confidentiality safeguards. (See discussion in the Appendix).

Cattle and Calves

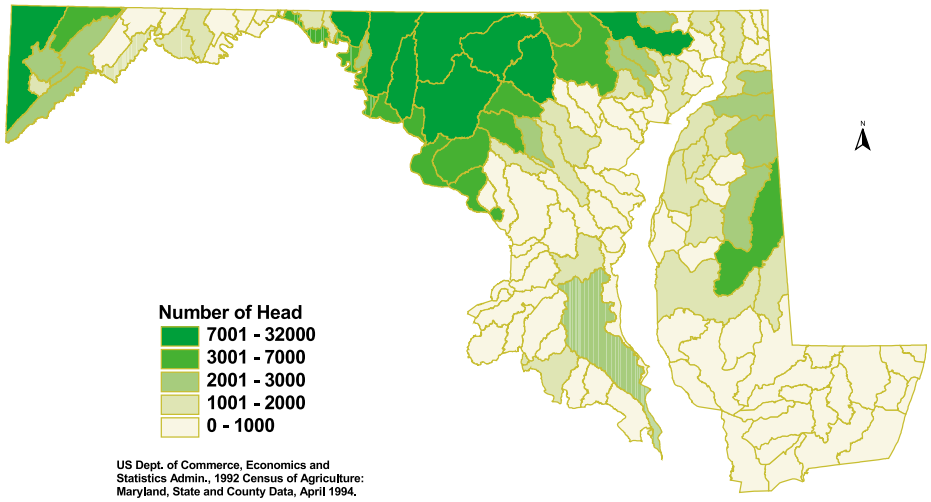
Cattle and calves represent a significant portion of Maryland's livestock production system. In 1995, approximately 315,000 head of cattle and calves, and 119,710,000 pounds of cattle and calves were marketed, accounting for $59,962,000 in cash receipts. The map in Figure 12 represents the number of cattle and calves using the smaller Maryland eight-digit watersheds. The largest number of cattle and calves were located in central Maryland, as many of the watersheds in that area of the state contained 3,001-7,000+ head each. However, a significant number of cattle and calves were located in western Maryland watersheds and watersheds bordering the eastern and southwestern banks of the Chesapeake

Livestock

- Maryland contained 315,000 head of cattle and calves in 1995
- Cash receipts for cattle and calves totaled $59,962,000
- Maryland contained 92,000 milk cows
- Cash receipts for milk totaled $175,824,000

Bay. In general, the watersheds bordering the western banks of the Chesapeake Bay and those in southeastern Maryland contained the least amount of cattle and calves; many watersheds in those areas contained only 0-1,000 head each.

Figure 12. Cattle and Calves by Watershed



Milk Cows

Milk is also a significant part of Maryland's livestock production system. In 1995, more than 1.3 billion pounds of milk were produced by 92,000 milk cows, accounting for $175,824,000 in cash receipts. The map in Figure 13 represents the number of milk cows using the smaller Maryland eight-digit watersheds. Watersheds in central Maryland contained the largest number of milk cows, each containing 1,001-4,001+ head.

Eastern and far western Maryland also contained a significant number of milk cows. In general, the watersheds west and southeast of the Chesapeake Bay contained the smallest number of milk cows; many watersheds in those areas contained only 0-100 head each.

Figure 13. Milk Cows by Watershed

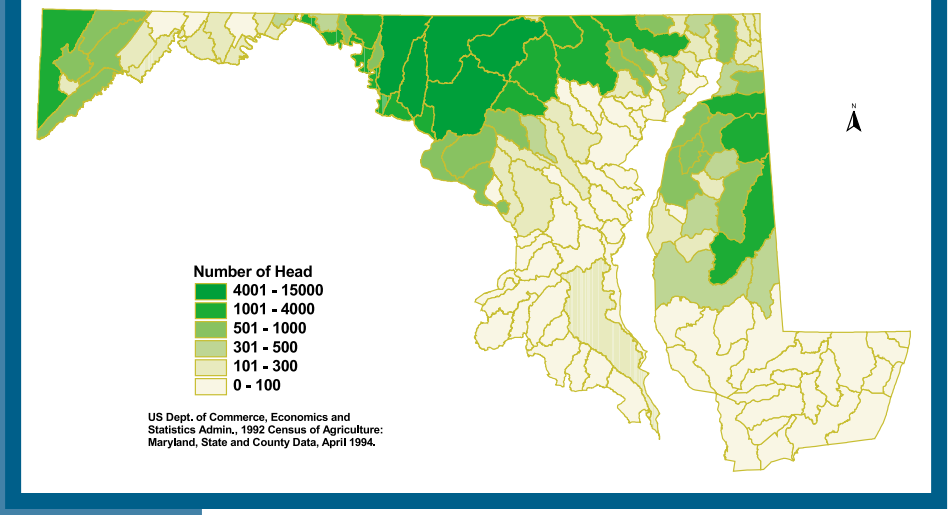
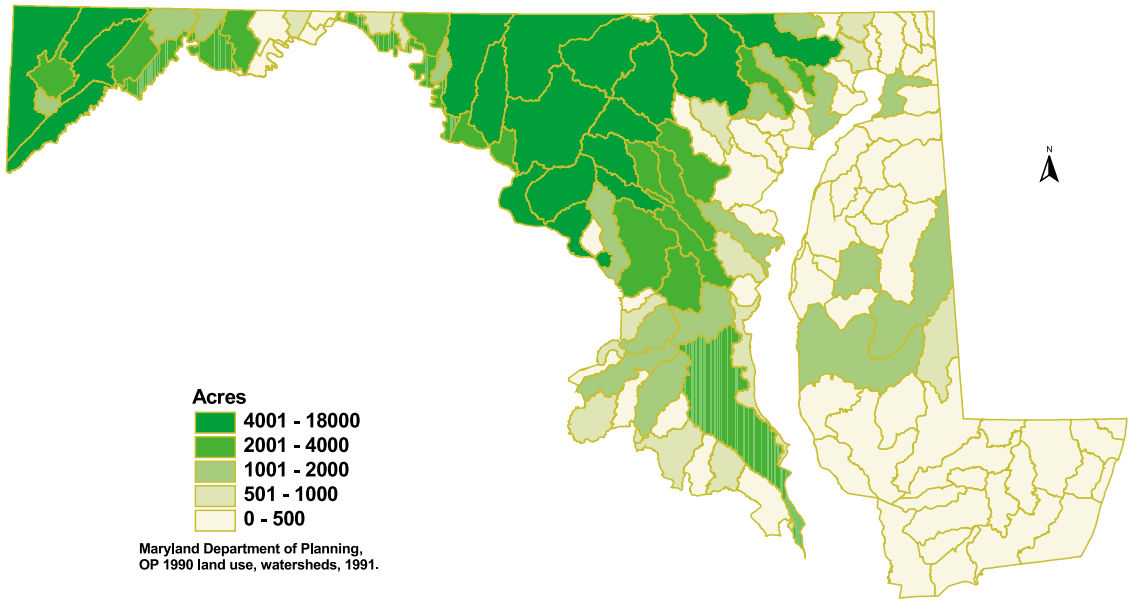


Figure 14. Pasture Acres by Watershed



Pasture Acres

The map in Figure 14 presents the amount of pasture acres by Maryland eight-digit watersheds. This map was based on 1990 data from the Maryland Office of Planning (MOP, 1991). Pastures can include areas occupied by beef cattle, dairy cattle, horses, sheep, and/or hogs. Pasture areas can have a significant impact on the surrounding environment. Livestock can trample river banks, destroy vegetation, and/or stir up sediment in streambeds resulting in soil erosion and excess nutrients entering rivers and streams. In addition, inadequate animal waste storage structures can lead to animal waste runoff into nearby waterways.

The watersheds in central and western Maryland contained the largest amount of pasture acres, with areas ranging from 2,001- 4,001+ acres each. In addition, the watersheds directly west of the Chesapeake Bay also contained a large amount of pasture acres; many of the watersheds in that area contained 1,001-4,000 acres each. The watersheds east of the Chesapeake Bay, as well as those on the eastern shore, contained the smallest amount of pasture acres; many watersheds in those areas contained only 0-500 acres each.

AGRICULTURAL INTENSITY BY WATERSHED

This section provides further analysis of the Maryland agricultural production system by assessing the overall extent of agricultural production within the different watersheds. The purpose of this section is to sum up the data on the extent of crops and livestock, provided thus far on a watershed-by-watershed basis, in order to provide a clearer understanding of each watershed's agricultural intensity. As stated earlier, watersheds often cross state boundaries; therefore, having agricultural data on a watershed basis from each state will allow resource managers to compare agricultural data across state lines and gain a regional perspective.

Table 2 describes the size of each watershed, the portion which lies within Maryland's borders, and the extent of agricultural land use within each watershed. More specifically, the first column of Table 2 indicates the amount of land area within each watershed (in acres). The second and third columns list the amount of each watershed's land area (in acres and as a percent) that lies within Maryland's borders.

Table 2. Area of Watersheds in Maryland and Extent of Agricultural Lands

USGS 8-digit Watersheds	HUC-8	Total Area of Watershed (Acres)	Land Area in MD (Acres)	Percent Land Area in MD	Farm Area in MD (Acres)	Percent Farm Area in MD
Choptank	02060005	595,326	492,480	83	279,457	57
Chester-Sassafras	02060002	775,661	642,445	83	359,069	56
Lower Susquehanna	02050306	1,585,376	175,955	11	81,920	47
Monocacy	02070009	630,806	494,605	78	223,211	45
Middle Potomac-Catoctin	02070008	785,530	299,204	38	129,867	43
Nanticoke	02060008	532,732	215,204	40	89545	42
Blackwater-Wicomico	02060007	342,543	310,910	91	123,410	40
Pocomoke	02060009	498,813	435,283	87	155,690	36
Conococheague-Opequon	02070004	1,460,096	300,438	21	89,220	20
Gunpowder-Patapsco	02060003	911,430	882,349	97	228,642	26
Brandywine-Christina	02040205	511,125	4,165	1	1,032	25
Middle Potomac-Anacostia-Occoquan	02070010	844,928	229,184	27	52,012	23
Patuxent	02060006	590,220	590,220	100	122,200	21
Chincoteague	02060010	547,269	192,568	35	35,101	18
Lower Potomac	02070011	1,179,232	499,710	42	86,320	17
Youghiogheny	05020006	1,133,536	264,410	23	39,627	15
Severn	02060004	279,121	213,768	77	30,759	14
North Branch Potomac	02070002	860,589	332,125	39	32,346	10
Cacapon-Town	02070003	771,539	124,880	16	6,672	5

The fourth and fifth columns of Table 2 list how much of each watershed's land area within Maryland's borders is used for agriculture (in acres and as a percent). The table ranks each watershed by the percent of land area within Maryland that is used for agriculture. It is hoped that this will provide a clearer understanding of the agricultural intensity of each USGS 8-digit watershed within Maryland.

The next section provides short descriptions of each watershed in terms of farm acreage and livestock products. Table 3, Page 20, compares the extent of crop production within each watershed, and Table 4, Page 21, compares the extent of livestock within each watershed.

Watershed Descriptions

The following watershed summaries are based on the relative size of agricultural activities, comparing the portion of the watersheds located in Maryland. For each watershed, the total farm acreage, the crops with the largest amount of harvested acreage, and the approximate number of cattle, calves and milk cows within the watershed are discussed. It is important to note that in some instances, the crop with the largest amount of harvested acreage within a watershed is a crop not discussed in this report, (e.g., fruit). However, because those crops are not included in this report, only the largest crops out of those selected for this report are mentioned. In addition, the number of cattle and calves and milk cows listed below for each USGS 8-digit watershed are approximations, because the data for those activities were summarized by the smaller Maryland 8-digit watersheds and are available only as ranges.

Choptank Watershed - 02060005

This watershed has a very large amount of agricultural land use; it contains 279,457 acres of farmland, second largest among the 19 Maryland watersheds. Soybeans has the largest amount of harvested acreage, at 112,912 acres. Other large crops include corn, at 61,641 acres, and wheat, at 51,974 acres. This watershed also contains a large number of cattle and calves, ranging from 3,001-7,000 head, and milk cows, ranging from 1,001-4,000 head.

Chester-Sassafras Watershed - 02060002

This watershed has a very large amount of agricultural land use; it contains 359,059 acres of farmland, more than any other watershed in Maryland. Soybeans has the largest amount of harvested acreage within this watershed, at 120,727 acres. Other large crops include corn, at 106,622 acres, and wheat, at 57,962 acres. This watershed also contains an average number of cattle and calves, ranging from 2,001-3,000 head. In addition, this watershed contains a large number of milk cows, ranging from 1,001-4,000 head.

Lower Susquehanna Watershed - 02050306

This watershed has an average amount of agricultural land use; it contains 81,920 acres of farmland. Corn has the largest amount of harvested acreage within this watershed, at 23,868 acres. Other large crops include soybeans, at 11,709 acres, and hay, at 10,342 acres. This watershed contains an average number of cattle and calves, ranging from 2,001-3,000 head, and milk cows, ranging from 501-1,000 head.

Monocacy Watershed - 02070009

This watershed has a very large amount of agricultural land use; it contains 223,211 acres of farmland, fourth largest among the 19 watersheds. Hay has the largest amount of harvested acreage within this watershed, at 56,218 acres. Other large crops include corn, at 49,154 acres, and soybeans, at 29,517 acres. This watershed also contains a large number of cattle and calves, at 7,000+ head, and milk cows, at 4,001+ head.

Middle Potomac-Catoctin Watershed - 02070008

This watershed has a large amount of agricultural land use; it contains 129,687 acres of farmland. Soybeans has the largest amount of harvested acreage, at 25,963 acres. Other large crops include hay, at 23,440 acres, and corn, at 19,840 acres. This watershed also contains a large number of cattle and calves at 7,000+ head, and milk cows at 4,001+ head.

Nanticoke Watershed - 02060008

This watershed has an average amount of agricultural land use; it contains 89,545 acres of farmland. Soybeans, at 38,074 acres has the largest amount of harvested acreage. Other large crops include wheat, at 15,186 acres, and corn, at 14,880 acres. This watershed also contains an average number of cattle and calves, ranging from 1,001-2,000 head, and milk cows, ranging from 301-500 head.

Blackwater-Wicomico Watershed- 02060007

This watershed has a large amount of agricultural land use; it contains 123,410 acres of farmland. Soybeans, at 22,857 acres has the largest amount of harvested acreage. Other large crops include wheat, at 16,636 acres, and corn, at 15,981 acres. This watershed contains a small number of cattle and calves, ranging from 0-1,000 head, and milk cows, ranging from 0-100 head.

Pocomoke Watershed - 02060009

This watershed has a large amount of agricultural land use; it contains 155,690 acres of farmland. Soybeans has the largest amount of harvested acreage within this watershed, at 64,292 acres. Other large crops include corn, at 38,996 acres, and wheat, at 16,068 acres. This watershed only contains a small number of cattle and calves, ranging from 0-1,000 head, and milk cows, ranging from 0-100 head.

Conococheague-Opequon Watershed - 02070004

This watershed has an average amount of agricultural land use; it contains 89,220 acres of farmland. Corn has the largest amount of harvested acreage, at 20,220 acres. Other crops include hay, at 19,008 acres, and soybeans, at 9,569 acres. This watershed does contain a large number of cattle and calves, at 7,000+ head, and milk cows, at 4,001+ head.

Gunpowder-Patapsco Watershed - 02060003

This watershed has the third largest amount of agricultural land use; it contains 228,642 acres of farmland. Corn has the largest amount of harvested acreage, at 51,519 acres. Other large crops include soybeans, at 35,696 acres, and hay, at 23,098 acres. This watershed also contains a very large number of cattle and calves at 7,000+ head, and a large number of milk cows, ranging from 1,001-4,000 head.

Brandywine-Christina Watershed - 02040205

This watershed has a small amount of agricultural land use; it contains only 1,032 acres of farmland, lowest of the 19 watersheds. Soybeans has the largest amount of harvested acreage, at 448 acres. This watershed only contains a small number of cattle and calves, ranging from 0-1,000 head, and an average number of milk cows, ranging from 101-300 head.

Middle Potomac-Anacostia-Occoquan Watershed - 02070010

This watershed has a relatively small amount of agricultural land use; it contains only 52,022 acres of farmland. Hay has the largest amount of harvested acreage within this watershed, at 2,056 acres. The second largest crop is wheat, at 1,845 acres. This watershed also contains only a small number of cattle and calves, ranging from 0-1,000 head, and milk cows, ranging from 101-300 head.

Patuxent Watershed - 02060006

This watershed has a large amount of agricultural land use; it contains 122,200 acres of farmland. Soybeans has the largest amount of harvested acreage, at 23,093 acres. Other large crops include corn, at 20,171 acres, and hay, at 15,126 acres. This watershed also contains an average number of cattle and calves, ranging from 2,001-3,000 head, and milk cows, ranging from 101-300 head.

Chincoteague Watershed - 02060010

This watershed has a small amount of agricultural activity; it only contains 35,101 acres of farmland. Soybeans has the largest amount of harvested acreage, at 12,707 acres. This watershed only contains a small number of cattle and calves, ranging from 0-1,000 head, and milk cows, ranging from 0-100 head.

Lower Potomac Watershed - 02070011

This watershed has an average amount of agricultural land use; it contains 86,320 acres of farmland. Soybeans has the largest amount of harvested acreage within this watershed at 22,857 acres. Other large crops include wheat, at 11,534 acres and corn, at 7,943 acres. This watershed contains an average number of cattle and calves, ranging from 1,001-2,000 head, and milk cows, ranging from 0-100 head.

Youghiogheny Watershed - 05020006

This watershed has a small amount of agricultural land use; it contains only 39,637 acres of farmland. Hay has the largest amount of harvested acreage, at 13,366 acres. However, this watershed contains a relatively large number of cattle and calves, at 7,000+ head, and milk cows, ranging from 1,001-4,000 head.

Table 3. Extent of Crops by Watershed*

Watersheds	Soybeans	Corn	Wheat	Hay	Barley	Tobacco	Oats	Totals
Choptank								
Chester-Sassafras								
Lower Susquehanna								
Monocacy								
Middle Potomac-Catoctin								
Nanticoke								
Blackwater-Wicomico								
Pocomoke								
Conococheague-Opequon								
Gunpowder-Patapsco								
Patuxent								
Lower Potomac								
Middle Pot.-Ana.-Occ.								
Brandywine-Christina								
Chincoteague								
Youghiogheny								
Severn								
North Branch Potomac								
Cacapon-Town								

*The colors in Table 3 correspond to the colors in the maps where dark green represents a relatively large amount of acreage within the watershed, and light green and yellow (in descending order) represent relatively smaller amounts of acreage within the watershed.

Table 4. Extent of Livestock by Watershed*

Watersheds	Pasture Acres	Cattle & Calves	Milk Cows
Monocacy			
Gunpowder-Patapsco			
Conococheague-Opequon			
Middle Potomac-Catoctin			
Patuxent			
Chester-Sassafras			
North Branch Potomac			
Lower Susquehanna			
Youghiogheny			
Lower Potomac			
Choptank			
Middle Pot.-Ana.-Occ.			
Severn			
Cacapon-Town			
Pocomoke			
Blackwater-Wicomico			
Nanticoke			
Chincoteague			
Brandywine-Christina			

*The colors in Table 4 correspond to the colors in the maps where dark green represents a relatively large amount of livestock within the watershed, and light green and yellow represent relatively smaller amounts of livestock within the watershed.

Severn Watershed - 02060004

This watershed has a relatively small amount of agricultural land use; it contains only 30,759 acres of farmland. Soybeans has the largest amount of harvested acreage, at 4,166 acres. This watershed contains an average number of cattle and calves, ranging from 2,001-3,000 head, and a low number of milk cows, ranging from 101-300 head.

North Branch Potomac Watershed - 02070002

This watershed has a low amount of agricultural land use; it only contains 32,346 acres of farmland. Hay has the largest amount of harvested acreage, at 9,937 acres. This watershed contains an average number of cattle and calves, ranging from 2,001-3,000 head, and milk cows, ranging from 501-1,000 head.

Cacapon-Town Watershed - 02070003

This watershed has a very small amount of agricultural land use; it contains only 6,672 acres of farmland. Hay has the largest amount of harvested acreage, at 2,098 acres. This watershed contains an average number of cattle and calves, ranging from 1,001-2,000 head, and a small number of milk cows, ranging from 101-300 head.

ENVIRONMENTAL CONCERNS

As important as the agricultural industry is, concerns have risen over the last decade about the impacts it can have on its surrounding environment. Agricultural production can have adverse effects on the environment due to soil erosion, excess nutrients, animal waste, and pesticides. Through soil erosion and surface water runoff, pesticides and excess nutrients, such as nitrogen and phosphorus, can find their way into and pollute nearby waterways. In addition, if not managed efficiently, animal waste can pollute nearby rivers and streams, and animals themselves can trample fragile streambeds, increasing the likelihood of soil erosion.

This section presents summary data on the application rates of agricultural chemicals, such as pesticides and fertilizers, within Maryland's counties. In addition, this section discusses some of the programs and management practices being implemented in Maryland to reduce the impacts of agricultural production on the environment.

Pesticide Use in Maryland

Pesticides are used for a variety of agricultural, domestic (home/garden), and public health purposes. In general, a pesticide is an agent used to control insects, weeds, bacteria, and other organisms. Data were evaluated to identify the geographic areas of Maryland with the largest use of pesticides (for all types of uses). Watershed- and crop-specific pesticide use data were not analyzed, so only county level data were used for this purpose (MDA, 1996). (See Appendix for further information on the method for collecting pesticide data.) Shown in Table 5 are the number of pesticides and total amounts (in pounds) of active ingredients in pesticides used in the Maryland

Table 5. Pesticide Applications by County in Maryland - 1994

Rank	County	Number of Pesticides Applied	Amount of Pesticides Applied (pounds active ingredient)
1	Washington	119	2,360,151
2	Montgomery	164	2,292,499
3	Wicomico	132	2,080,090
4	Cecil	129	1,253,188
5	Caroline	115	980,188
6	Queen Annes	105	853,733
7	Dorchester	95	528,320
8	Talbot	112	454,829
9	Kent	85	432,144
10	Baltimore	174	400,628
11	Frederick	119	346,655
12	Worcester	115	305,379
13	Harford	133	294,405
14	Carroll	116	277,907
15	Anne Arundel	128	198,175
16	Prince Georges	145	146,262
17	Somerset	72	139,896
18	Garrett	58	97,852
19	Baltimore City	80	93,404
20	Charles	113	92,819
21	St Marys	96	91,742
22	Howard	117	88,704
23	Calvert	80	42,764
24	Allegany	41	26,798
Total in Maryland		**252***	**13,881,629****

Source: MDA, 1996. This information represents all uses (e.g., agricultural, home/garden, etc.) and is not limited to the types of crops analyzed in this report.

* Different types.

** Total amount of pesticides applied includes some chemicals that were reported but not estimated on a county basis.

counties in 1994. More than 13-million pounds of 252 different types of active ingredients in pesticides were used in Maryland in 1994. In general, about 80 percent of the volume of pesticides are used for agricultural purposes nationwide (U.S. EPA, 1997). Maryland counties with the largest pesticide use were Washington (2.36 million pounds), Montgomery (2.29 million pounds), Wicomico (2.08 million pounds), and Cecil (1.25 million pounds). As shown in Table 6, most of the pesticides used were herbicides (5.68 million pounds - 41 percent) and wood preservatives (5.64 million pounds - 41 percent). Almost 1 million pounds (997,913 pounds) of insecticides were used in Maryland during 1994 as shown in Table 7, including chlorpyrifos (240,325 pounds), petroleum oils (221,603 pounds), and malathion (121,112 pounds). The herbicides used in the largest quantities were metolachlor (2.17 million pounds) and atrazine (1.66 million pounds) as shown in Table 8.

Table 6. Pesticide Uses Reported in Maryland in 1994

Type	Amount Used (pounds active ingredient)	Total Pesticide Usage (%)
Herbicides	5,677,775	41
Insecticides	997,913	7
Fungicides	301,612	2
Wood Preservatives	5,642,676	41
Antifoulants	1,154,042	8
Others	107,611	1

Table 7. Top 10 Reported Insecticides Used in Maryland in 1994

Rank	Name of Insecticide	Pounds of Active Ingredient Used
1	Chlorpyrifos	240,325
2	Petroleum Oils	221,603
3	Malathion	121,112
4	Permethrin	82,985
5	Boric Acid	47,992
6	Carbaryl	39,352
7	Propetamphos	30,215
8	Acephate	28,013
9	Terbufos	20,395
10	Dimethoate	20,174

Table 8. Top 10 Reported Herbicides Used in Maryland in 1994

Rank	Name of Herbicide	Pounds of Active Ingredient Used
1	Metolachlor	2,166,308
2	Atrazine	1,166,064
3	Glyphoate	410,291
4	Alachlor	263,251
5	2, 4-D	226,054
6	Pendimethalin	188,506
7	Paraquat	175,607
8	Simazine	153,240
9	Metribuzin	88,604
10	Cyanazine	85,077

Source: MDA, 1996. This information represents all uses (e.g., agricultural, home/garden, etc.) and is not limited to the types of crops analyzed in this report.

Fertilizer Use in Maryland

Data were evaluated to identify the geographic areas of Maryland with the largest use of fertilizers. Watershed- and crop-specific fertilizer use data were not analyzed, so data on the county level were used for this purpose. Shown in Table 9 are the amounts (in tons) of active ingredients in fertilizers (nitrogen, phosphate, and potassium) used in the Maryland counties. In addition, please note that the information shown in Table 9 only includes commercial fertilizers, not manure. (See Appendix for further information on the method for collecting fertilizer data.)

From Table 9, you can see that more than 150,000 tons of the active ingredients in fertilizers were used in Maryland in 1997. The counties with the largest fertilizer use were Caroline (14,833 tons), Carroll (14,586 tons), Frederick (11,929 tons), and Harford (11,773 tons). In general, the counties on the Eastern Shore and in central Maryland, several of which adjoin the Chesapeake Bay, had the largest fertilizer use in the state. Future assessments will include fertilizer application data for the crops analyzed in this report. In addition, use of fertilizers in watersheds will be assessed; this analysis will facilitate further analyses of fertilizer use and water quality.

Table 9. Fertilizer Application by County in Maryland - 1997

Rank	County	Major Nutrients Applied (Tons)			
		Nitrogen (N)	Phosphate (P_2O_5)	Potassium (K_20)	Total
1	Caroline	6,043	2,411	6,379	14,833
2	Carroll	7,516	3,262	3,808	14,586
3	Frederick	5,353	2,894	3,682	11,929
4	Harford	6,776	2,142	2,855	11,773
5	Queen Annes	4,526	1,750	2,620	8,896
6	Washington	3,294	3,740	1,608	8,642
7	Kent	3,580	2,655	2,054	8,289
8	Wicomico	3,506	1,176	3,108	7,790
9	Talbot	2,959	1,300	2,623	6,882
10	Baltimore	4,385	973	852	6,210
11	St Marys	2,201	1,708	1,877	5,786
12	Anne Arundel	2,606	1,391	1,666	5,663
13	Baltimore City	1,796	3,341	495	5,632
14	Worcester	2,895	842	1,771	5,508
15	Prince Georges	3,046	864	1,127	5,037
16	Dorchester	1,779	913	1,754	4,446
17	Cecil	1,800	1,093	1,341	4,234
18	Garrett	917	759	957	2,633
19	Montgomery	1,301	501	547	2,349
20	Howard	979	512	632	2,123
21	Somerset	701	216	707	1,624
22	Allegany	538	323	472	1333
23	Charles	543	207	243	993
24	Calvert	273	147	196	616
	Unknown	4,542	694	648	5,884
	Total	**73,855**	**35,814**	**44,022**	**153,691**

Source: USDA, 1999c. This information represents all uses (e.g., agricultural, home/garden, etc.) and is not limited to the types of crops analyzed in this report.

Mitigation

Besides agriculture being a potential stressor on adjacent resources such as rivers and streams, it can also be a cumulative stressor whose impact may be seen some distance away. Increased loadings of nutrients, sediment, and other pollutants in the rivers and streams that feed the Chesapeake Bay can significantly impact the quality of the resources on which much of the agricultural industry, the seafood industry, and many recreational activities depend.

Maryland's agricultural industry is determined to protect its environment. A number of goals are set for reducing the amount of certain types of chemicals and waste being released into the water and air. For instance, Maryland was committed to reducing the amount of nitrogen and phosphorus entering the Chesapeake Bay by 40 percent of the 1985 loads by the year 2000 (MDE, 1999a). This involves a variety of programs, some of which are described below. In addition to the goals Maryland has set for itself, all states are required by the Federal Clean Water Act to develop Total Maximum Daily Loads (TMDLs). TMDLs are an estimate of the maximum amount of a given pollutant that a body of water can assimilate without violating water quality standards (MDE, 1999b). These TMDLs will give Maryland a mechanism for formalizing its upper limits on the amount of nitrogen and phosphorus that may enter its waterbodies, and to help ensure clean waters in the future.

Maryland has taken many other actions to minimize the impact of agriculture on the environment. For instance, the Governor of Maryland appointed various individuals selected from state agencies, local governments, industry, environmental groups, agriculture, and concerned citizens to work on Tributary Teams focused on implementing "Tributary Strategies" developed in 1993 and 1994 (MDE, 1998). These strategies are comprehensive watershed-based plans to reduce the amount of nutrients entering the Chesapeake Bay from ten key tributaries. Assisting with this effort is the Office of Resource Conservation in Maryland's Department of Agriculture, which works with citizens, farmers, businesses, and local governments to help develop these "Tributary Strategies." Among the pollution control options being implemented are best management practices (BMPs) and the planting of stream-side vegetation to absorb nutrient runoff from farms (MDNR, 1999).

BMPs are conservation tools designed to protect the quality of Maryland's waterways by preventing and controlling soil erosion, nutrient runoff, and animal waste runoff. Local soil and water conservation districts provide farmers with the technical and financial assistance they need to implement these BMPs. In 1994, soil and water quality plans were developed for over 113,000 acres of Maryland farmland, and Maryland farmers installed more than 19,000 BMPs (MFB, 1999). Soil and water quality plans have now been developed for more than 40 percent of Maryland's agricultural land since 1985 (MFB, 1999). BMPs, such as creating manure storage structures, properly using commercial fertilizers, farming with the contour, and stabilizing shorelines, will all be useful in reducing nutrient runoff and other forms of pollution.

One program that helps farmers cover the costs of installing BMPs on their farms is the Maryland Agricultural Water Quality Cost-Share (MACS) program. In FY 1998, MACS helped Maryland farmers install more than 650 projects, totaling more than $4 million in grant payments (MDA, 1998b). It is important to mention, that in addition to these funds, farmers personally contributed significant resources toward the completion of these projects. These projects will have positive benefits to more than 11,000 acres of land by preventing some 43,000 tons of soil from reaching Maryland waterways and managing an estimated 740 tons of animal waste more efficiently (MDA, 1998b).

Maryland's Targeted Watershed Project is another program aimed at protecting the Chesapeake Bay by reducing the amount of nutrients and sediment that enters the rivers and streams that feed into the Bay. This project focuses on improving the water quality of four relatively small watersheds used heavily for agriculture. Under this program, a Soil Conservation District (SCD) nutrient management specialist works with farmers to implement nutrient management practices. These targeted watersheds are the focus of a pilot project demonstration of how state and local cooperation can have a positive impact (USEPA, 1999b).

It is also important to mention that in the spring of 1998, the Maryland General Assembly passed the Water Quality Improvement Act (WQIA). WQIA set a time-table for certain agricultural operations to implement nitrogen-and phosphorus-based nutrient management plans. Agricultural operations obligated to develop these plans are those with annual incomes greater than $2,500, or more than eight animals, and those using sludge or animal manure as fertilizer.

Future assessments of environmentally relevant aspects of agriculture in Maryland will include pesticide application data for the crops analyzed in this report. In addition, use of agricultural chemicals in watersheds will be assessed; this will facilitate further analyses of relationships between agricultural production and water quality.

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APPENDIX: METHODOLOGY

The majority of data used in this report are 1995 data collected by the Maryland Agricultural Statistics Service and 1992 data taken from the Census of Agriculture. Employing the most sophisticated sampling and census techniques, the Service developed data series for a wide range of crop and livestock production items, land use, prices, and data to measure the economic performance of the agriculture production sector. The data were collected at the state level, then special techniques were employed to re-project the data on a watershed basis. Additional methods were used to estimate potential environmentally relevant attributes of the Maryland agricultural production system, such as application rates of fertilizers and other agricultural chemicals for various crops.

Crop Acreage

Data Source/Collection Method

The source of the crop data presented in this report is primarily 1995 data from the Maryland Agriculture Statistics Service. A variety of sampling and survey methods were used to collect these data, depending on the nature of the individual populations. For example, populations of growers for some products are so small that their production, the land area devoted to the products, and the value of their sales can only be determined by a complete count of the item in question. Costs associated with accurate estimates of the population of other commodities and land uses frequently dictate the use of complex sampling techniques. For example, the cost of a complete inventory of land devoted to corn in the state is normally prohibitive; therefore, a statistically-based sampling approach is used. It is necessary to utilize area frame methodology or a combination of area frame and list frame sampling to measure this variable.The Maryland Agricultural Statistics Service employs three major data collection techniques or a combination thereof. These techniques are mail surveys, telephone surveys, and face-to-face interviews. Grower-reported data were reviewed for reasonableness and consistency with general cultural practices, farm legislation, and historical estimates. Harvested acreage estimates were based on survey estimates and the historical relationship between planted and harvested acres.

The analysis for this project was carried out by the Maryland Agricultural Statistics Service and the U.S. Environmental Protection Agency (EPA), Office of Research and Development. Survey methodology and the resulting data were combined with geographic information to develop new information indicating the distribution of crop data to geographic areas in Maryland. The Service currently collects annual data sufficiently accurate for the compilation of county crop estimates for most crops. The estimates of harvested acreage in this report are based primarily on surveys conducted the first two weeks of December. These surveys are based on a probability area frame survey with a sample of approximately 200 segments or parcels of land (average approximately 1 square mile) and a probability list sample of about 1,000 farm operators. Enumerators conducting the area survey contact all farmers having

Data Collection and Analysis Methodology

- Maryland Department of Agriculture 1995 Data for Crops and 1992 Census of Agriculture Data for Livestock
- Statistically-based Sampling
- Projection of Data onto Watersheds
- Estimates of Agricultural Land Area in 19 Watersheds in Maryland

operations within the sampled segments of land and account for their operations. From these data, statewide estimates can be calculated. Responses from the list sample, plus data from the area operations that were not on the list to be sampled, are combined to provide another estimate of acreage.

The surveys conducted by the Maryland Agricultural Statistics Service are designed to provide accurate state-level estimates of harvested acres for most crops, but are not expected to provide sufficient information for distribution of acreage to counties or watersheds. Therefore, a technique was devised to distribute the crop estimates to the 19 USGS eight-digit watersheds in Maryland. This distribution was based on allocating ZIP Codes to watersheds. ZIP Codes are associated with the operator of individual farms reporting, and these ZIP Codes provide the means for the distribution of the data to watersheds, as well as counties. The geographic boundaries of the ZIP Codes and watersheds were available as spatial geographic information systems databases. The percentage of each ZIP Code area located in each watershed was determined using Geographic Information System (GIS) procedures. After this step was completed, statisticians distributed the data to each of the 19 USGS eight-digit watersheds based on the ZIP Code attached to each of the individual farm reports. The percentage of acres devoted to each crop was computed for each watershed. These percentages were then multiplied by the estimated acreage of farmland in each watershed to arrive at an estimate of the acres of each crop harvested in each watershed. The acreage of the crops in the watersheds were then summed to a state total for each crop and scaled to the current estimate of the acreage of the crops in the state.

Confidentiality of Data

Confidentiality is a critical issue when collecting data from individual farmers. In order to protect the rights of individual respondents, legal confidentiality provisions apply to all data collection efforts. This prevents analysis and presentation of select data sets where individual respondents could be revealed. Therefore, agriculture statistics data are summarized to a level where individual farmers cannot be identified. By doing this, the privacy rights of individual respondents are protected and they are more likely to continue to participate in data collection efforts in the future.

Limitations and Uncertainties

As with all data, there are limitations and uncertainties in the data collected for this report. The data presented in this report are primarily based on statistics utilizing survey methodology. The surveys used to make estimates are subject to sampling and non-sampling type errors that are common to all surveys. Sampling errors for major crops generally are between 1 and 6 percent. Sampling errors represent the variability between estimates that would result if many different samples were surveyed at the same time. Non-sampling errors cannot be measured directly but may occur due to planting intentions, incorrect reporting and/or recording, data omissions or duplications, and errors in processing. To minimize non-sampling errors, vigorous quality controls are used in the data collection process, and all data are carefully reviewed for consistency and reasonableness.

Some uncertainty results from the procedures used to apportion crop acreage data to the watersheds. There were instances when individual ZIP Codes were located in more than one watershed. Oftentimes, portions of the same ZIP Code area were located in two or three different watersheds.

For purposes of this study, when determining acreage numbers for a certain crop in the different watersheds, it was assumed that the crop was evenly distributed throughout the ZIP Code. However, crops are not usually distributed evenly throughout a ZIP Code, and this can lead to uncertainty in the results.

In addition, two of Maryland's watersheds, Upper Chesapeake Bay (02060001) and Shenandoah (02070007), are not included in this analysis. Both of these watersheds contain a very small amount of agricultural land in Maryland as the Upper Chesapeake Bay watershed contains very little land area, and the Shenandoah watershed lies only slightly within Maryland's borders. However, the omitting of these two watersheds may result in some small discrepancies when comparing the agricultural data presented in this analysis to those from other sources. For instance, when summing up the crop data for each watershed presented in this report, the total may not match the Maryland statewide total.

Livestock

Data Source/Collection Method

The procedures used to estimate data in the livestock section are similar to those used in the crop sections, where data on ZIP Code level were allocated to the eight-digit Maryland watersheds. Livestock data are presented for the 138 Maryland eight-digit watersheds, which are smaller than the 19 USGS eight-digit watersheds used to present the crop data. The primary source of livestock data for this report is the 1992 Census of Agriculture, conducted at 5-year intervals by the U.S. Department of Commerce - Bureau of the Census* (USDOC, 1994). The Census of Agriculture is a complete accounting of U.S. agricultural production and is the only source of uniform, comprehensive agricultural data for every county and state in the Nation (USDA, 1999a). Report forms are mailed to all farm and ranch operators who produced and sold, or normally would have produced and sold, $1,000 or more of agricultural products during the census year (USDA, 1999a). As a census, its intention is to accurately measure the density or average presence of items of interest at the county and state levels. The data collected in this survey from a large majority of the farming operations are supplemented to arrive at an estimate of the population.This is accomplished using imputation procedures based on area farm incompleteness determination and other sophisticated techniques. Any more detailed levels of data require more expensive resource intensive survey efforts, such as complete land inventory techniques.

*Recently, the responsibilities for the Census of Agriculture were transferred from the Department of Commerce to the National Agriculture Statistics Service (NASS) of the United States Department of Agriculture (USDA).

Limitations and Uncertainties

The development of estimates of livestock numbers in watersheds at a point in time involves problems not critical in cropland estimating. Livestock can move about, placing more emphasis on a shorter timeframe for data collection. In addition, livestock tend to be located in varying density throughout the area under study. If the use of the livestock data requires the exact number and location of every head of livestock in an area, then the only way to accurately estimate these numbers and the impact of their presence on the environment is to conduct a complete census of the areas under consideration. Sampling procedures generally are not sufficient to provide the accuracy needed to determine the effect livestock may have on small areas. For larger areas, such as a state or, in many cases, a county, the average number of cattle per acre being pastured in the area may provide the information needed for comparison with other states and counties and for accurate assessment of their environmental impact. If the data user desires to obtain a general view of the density of livestock in various regions in a state, then sample survey data can provide useful information of sufficient accuracy. If, on the other hand, one desired to assess the environmental impact of livestock in a small catchment, the only data development method providing sufficient accuracy for this purpose may be a complete enumeration (census) of the livestock in the area at a point in time.

Poultry

Broilers are another important part of the Maryland agricultural production system. In 1997, Maryland ranked eighth in the Nation for the number of broilers sold, with a value of over $500 million (NASS, 1999c). However, broilers were not included in this analysis because of the challenges involved in estimating their numbers on a watershed basis. As described below, many under-reporting errors were found when estimating broiler production at a state level; therefore, no attempt was made to re-project the data on a watershed basis.

Historically, the Census of Agriculture has "undercounted" broilers when compared with weekly and annual NASS surveys of hatcheries. This is common in all broiler estimating states to different degrees, but in Maryland the difference has been around a 13-15 percent undercount. Although NASS generally does not have a complete list of broiler contractees, and obtaining these lists is against the policy of most integrators, the census mail list probably contained 90-95 percent of the individual contractees. Following are two under-reporting errors found during the 1997 Census:

1) Many broiler growers did not report their broilers on hand or sold because they did not consider themselves as the owners; consequently, they assumed the integrators would report for them.

2) Broiler flocks are turned over on average 5-6 times per year, so the one-time inventory number should range from about 16-20 percent of the annual number sold, unless they are between flocks and have no current inventory on hand on the census reference date. Furthermore, some respondents obviously did not understand what the census wanted them to report as the relationship of number sold to inventory was considerably outside of the expected 5-6 range.

Estimates of Agricultural Chemical Usage

For pesticides, data were obtained from the Maryland Department of Agriculture representing 1994 (MDA, 1996). The survey used by the Maryland Department of Agriculture to develop the estimates included sending questionnaires to farmers, commercial applicators, and others. The mass of pesticide active ingredients (insecticides, herbicides, fungicides, etc.) was the basis for this assessment. Data on pesticide usage were not available for specific crops or on a watershed basis; therefore, county-level data were examined to identify the geographic areas of Maryland with the largest use of pesticides. As with fertilizers, these pesticide data represent a variety of uses, such as agriculture, commercial applications, and private uses.These uses were very broad, including wood treatment (the pesticide used in the largest quantity was chromated copper arsenate); as a result, not all of these data were included in this analysis. As presented earlier in this report, use of more than 250 different pesticides was reported in 1994 (MDA,1996).

Fertilizer use data were obtained from Maryland Department of Agriculture from the 1997 Census of Agriculture. Fertilizer use data are presented by county. Crop- and watershed-specific fertilizer use estimates were not prepared as part of this analysis. The data represent the mass of active ingredients used in single- and multiple-nutrient fertilizers. As such, the amounts (in tons) of nutrients in fertilizers (nitrogen, phosphate, and potassium) were examined to identify the geographic areas of Maryland with the largest use. It should be noted that these data represent uses of fertilizers for many purposes, including agricultural uses on crops other than those examined in this report, as well as other types of uses.

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